CANYONLANDS NATIONAL PARK
RESEARCH SUMMARY 2010

1) Study Title: Population monitoring of humpback and bonytail chub in Cataract Canyon
Permit No.: CANY-2010-SCI-0001
Principal Investigator: Paul Badame
Purpose of Scientific Study: Goals: Maintenance of long term catch rate trend data, longitudinal distributions, and population size structures for humpback and bonytail within Cataract Canyon.
Objectives: 1. Complete one ten day pass each year sampling five sites within Cataract Canyon.
2. Obtain highest possible rates of capture of humpback and bonytail within concentration habitats and maximize number of individuals marked and captured at each sampling site.
3. Determine annual catch rate trend for chubs, examine population size structure, and compare longitudinal distribution to past years.
Findings/Accomplishments for 2010: Complete one sampling trip in Cataract Canyon in October 2010. Annual sampling was conducted October 21-28 2010 at the three long-term trend monitoring sites and at rapid 12 (Figure 1). Daily mean flows ranged from 6563 â 8282 ft3/sec (Figure 3) and water temperatures ranged from 13.9 â 11.1 ÂºC. No sites were sampled below the Big Drop rapids.
Humpbacks: A total of 14 Humpback chub were captured in 2010. Of these 11 were caught in trammel nets during 566.2 hours of effort resulting in a catch rate of .019 Humpbacks/ net hr. All Humpback chub caught by trammel nets were adults (i.e. >150 mm) with a mean total length of 225.2 mm. Electrofishing yielded three juvenile (i.e. <150 mm) Humpback chub during 4.12 hours of sampling resulting in a catch rate of .73 Humpbacks/ hr. No Humpback chub tagged prior to the 2010 were caught.
Bonytails: Two adult Bonytail were captured in trammel nets in 2010 at rapid 10 (RM 207.3-208.3). Their lengths were 265 and 255 mm. The 255 mm fish was initially stocked in April 1998 at river mile 94 on the Colorado River. It was recaptured in the Green River at river mile 341.2 in October 2008. During this time this fish grew a total 149 mm gaining 21 mm over the previous two years. The other Bonytail was not previously marked.
Overall Catch: A total of 163 fish consisting of 14 species were captured by trammel nets in Cataract Canyon in 2010. Humpback chub, Razorback sucker, and Bonytail made up 12.9% of the total sample. The total catch was comprised of 20.9 % natives. Humpback chub and channel catfish were the most common native and nonnative species present (Table 2). One hundred twenty five fish were encountered during electrofishing efforts. Endangered species, native species and nonnative species made up 3.2%, 5.6%, and 94.4% of the sample, respectively. Channel catfish and gizzard shad were the most abundant species in the sample.

2) Study Title: Assessment of Stocked Razorback Sucker and Colorado Pikeminnow Reproduction in the Lower Green River via Larvae and Young of Year Collections.
Permit No.: CANY-2010-SCI-0002
Principal Investigator: Paul Badame
Purpose of Scientific Study: This project targeted determining and monitoring early life stages of endangered fish in the Colorado River drainage, specifically the Colorado pikeminnow (Ptychocheilus lucius) and the razorback sucker (Xyrauchen texanus). Monitoring of young-of-the-year (YOY) Colorado pikeminnow was initiated in 1986 within the upper Colorado River basin as part of the Interagency Standardized Monitoring Protocol (ISMP). The ISMP sampling in the lower Green and Colorado Rivers was proposed to monitor recruitment success of first year endangered fishes, to correlate cohort strength

and condition to abiotic and biotic parameters, and to provide data for a predictive model measuring future cohort strength. Since its inception, the ISMP protocol has been updated to refine its scope and methods to focus not only on pikeminnow but all small-bodied fishes allowing for assessment of other projects such as nonnative control actions. A comprehensive synthesis of the effect of changes in physical habitat (as a function of flow and flow variability) and other environmental conditions on the small-bodied fish community (emphasis on Colorado pikeminnow) is underway.

Another aspect of this project is designed as a pilot study to determine the presence/ absence of early life stages of endangered razorback sucker in lower Green River. By the mid 1990s most wild riverine adult razorbacks in the Green River basin were limited to one population in the middle Green River with an estimated size of about 500 adults (Modde et al. 1996). Although sampling from 1992-96 did verify the presence of larval razorback in both the middle and lower Green River it was believed that mortality rates on those larvae were very high and did not provide any significant recruitment into the wild population (Muth et al. 1998). Habitats were identified for razorback sucker larvae as ephemeral shoreline, ponded lower portions of flooded tributary streams, side canyons, washes, canals, and channels (Muth et al. 2000). Historic collections sites for larvae were Millard Canyon, the confluence of the San Rafael River, and Green River Valley area. By 2000, wild adult razorback suckers in the Green River Basin were very rare and the few remaining have likely perished (Bestgen et al. 2002). Stocking of hatchery reared razorback sucker in the Green River basin began in 1999 as a means to augment the population and continues through this current time (US Fish and Wildlife Service 2002). Thus, all current reproduction observed is likely by stocked adults. Determining the reproductive success of stocked fish in the Green River is key to understanding their ability to maintain a viable self sustaining population.

During sampling for adult Colorado pikeminnow (2001-2003 and 2006-2008; UDWR unpublished data), within the lower Green River, the occurrence of adult razorback captures had increased greatly from 9-10 individuals per year to an average of 320 captures between 2006 and 2008. In addition, during the 2007-08 adult pikeminnow sampling an increased number of ripe adult razorbacks have been captured throughout the lower Green River and in two specific locations congregations of ripe razorbacks displaying spawning behavior have been observed and captured. In 2008, three age 1+ razorbacks were captured within the lower Green as well.

This progression of events over the last three years strongly suggests that adult stocked razorback are now persisting in large enough numbers within the lower Green to facilitate successful spawning. Successful spawning among stocked razorback is an important component of a viable recovery for the species. Determining the timing, locations, and relative extent of larval recruitment will help define the success of the species. Sampling focused on year one survival of larvae will provide information about potential road blocks to recruitment of young suckers into the adult population.

Findings/Accomplishments for 2010: Razorback sucker: Light trap samples were collected in the Green River Valley between 16 May and 23 June 2010. Forty eight light trap samples were collected from the Green River Valley. Of these 27 were sent to the CSU larval fish lab. Ninety four light trap samples were collected at downstream sites between river miles 105.4 and 19.5. Fifty seven samples were sent to the CSU larval fish lab for identification.

A 1 meter kick seine was used to collect 78 larval fish samples from flooded tributaries, side channels, backwaters, and embayments between 17 May 2010 and 24 June 2010. A total of 476 m2 of suitable habitat was seined and 17 samples were sent to CSU larval fish lab to be identified.

Colorado pikeminnow: Annual monitoring for YOY Colorado pikeminnow in Reach 3 began on September 12 and was completed on September 14, 2010. Seining was conducted on the Green River from river-mile 120 (Green River State Park) to river-mile 0 (confluence

with the Colorado River). Samples were collected at two backwater habitats within every 5-mile sub-reach, as available. A total of 29 of 48 possible backwaters were sampled in 20 of 24 sub-reaches in the lower Green River. Lower Green River flows (measured at USGS Gage #9315000 in Green River) fell from 2300 cfs to 2280 cfs over the three days of sampling. The lower Green River, measured at USGS Gage #9315000 in Green River, peaked this year on June 10 at 23,900 cfs (Figure 1). This is slightly higher and later than the 46-year (since dam operation began in 1964) median peak of 17,400 cfs on May 28, but consistent with long-term trends. Basin-wide flash flooding in August caused significant changes to the fluvial geology of side canyons, outwashes, backwaters, sandbars, and the main channel of the Green River. At the time of sampling, some backwaters had been scoured out and were still flowing; some areas had been flushed out and dropped suddenly leaving isolated pools where backwaters once were; other backwater habitats were clogged with sediment and debris from nearby flash floods. These events and resulting changes to backwater habitats may be correlated to lower numbers and shorter lengths of Colorado pikeminnow found during sampling as fish may have been washed out of habitats they had moved into before flooding. Because the locations of these stochastic climatic events were downstream from the Green River gage, we cannot track them using the current flow data.
In the lower Green River, 131 YOY Colorado pikeminnow were captured and measured. All fish were sorted, identified and enumerated in the field. The number of YOY Colorado pikeminnow captured was less than in 2009 (423 fish). This is also lower than the 10-year average (193.70 fish/year), 15-year average (248.47 fish/year), and 25-year average (501.08 fish/year) (Table 4). The CPUE this year was 4.57 fish/100m2, lower than the 10-year and 15-year averages (6.27 fish/100m2 and 7.22 fish/100m2, respectively), and considerably lower than the 25-year average of 14.88 fish/100m2 (Table 4). The average length of YOY Colorado pikeminnow was 29.86 mm, shorter than the 10, 15, and 25-year averages (43.36 mm, 39.46 mm, and 39.24 mm, respectively) (Table 4).
Other native species captured in the lower Green River were 3 juvenile Colorado pikeminnow, 7 flannelmouth suckers, 3 bluehead suckers, and 12 speckled dace (Table 5). Nonnative captures were enumerated during the first seine haul in each primary habitat. Total catches in reach 3 was once again dominated by nonnative cyprinids. Five nonnative species were present compared to six in 2009 (Table 6). These included red shiners (n = 1028), sand shiners (n = 1025), fathead minnows (n = 150), green sunfish (n=5), and gizzard shad (n = 4).

3) Study Title: Ground Cover on Aeolian Dunes in the Colorado River Corridor Through Cataract Canyon, Canyonlands National Park
Permit No.: CANY-2010-SCI-0003
Principal Investigator: Amy Draut
Purpose of Scientific Study: The purpose of the proposed study is to evaluate landscape ground cover in aeolian (wind-formed) dune fields within the Colorado River corridor through Cataract Canyon, Canyonlands National Park. Ground-cover properties serve as a proxy for evaluating sediment supply to, and sediment mobility within, aeolian landscapes. This study would constitute part of an ongoing, long-term research program investigating the effects of Glen Canyon Dam on the Colorado River ecosystem; complementary data have already been collected from aeolian dune fields downstream of the dam, in Grand Canyon National Park. The source of sediment supplied to aeolian dune fields in the Colorado River corridor is primarily from fluvial (river-deposited) sandbars. Because Glen Canyon Dam has eliminated the mainstem sediment supply in the Colorado River below the dam, with consequent loss of fluvial sandbars in Grand Canyon, it is likely that aeolian dune fields too have therefore evolved differently in Cataract and Grand Canyons since the dam was closed in 1963. Studying aeolian landscapes in Cataract Canyon, a river reach with near-natural sediment supply and annual floods, will provide data that are not only valuable

for ecosystem monitoring in Canyonlands National Park, but that provide a critical comparison with landscapes affected by Glen Canyon Dam in Grand Canyon National Park. I propose to measure ground cover on aeolian dunes above the recent spring high-water line through Cataract Canyon. Measurements would include quantifying the amount and species of vegetation, amount of biologic crust, and amount of open sand space within dune fields, focusing on areas that are near (within 100 m) and downwind of fluvial sandbars that form by annual Colorado River floods. This work can be accomplished with minimal impact to resources, and is anticipated to generate results of great value to understanding the effects of dams on the Colorado River ecosystem with widespread applications to other arid riparian zones.
Findings/Accomplishments for 2010: Field work took place in July 2010 at 13 sites, listed in Table 1 of the report referenced here. The study successfully collected data on vegetation abundance and substrate composition in aeolian sand landscapes of Cataract Canyon, and we published the results in a USGS open-file report in December 2010: Draut, A.E., and Gillette, E.R., 2010, Vegetation and substrate on aeolian landscapes in the Colorado River corridor, Cataract Canyon, Utah: U.S. Geological Survey Open-File Report 2010-1273, 61 p., 14 tables, http://pubs.usgs.gov/of/2010/1273/. I also have a journal manuscript in review that compares those properties of Cataract Canyon aeolian landscapes with those downstream of Glen Canyon Dam, in Grand Canyon National Park. When that gets published, I will send it to Canyonlands NP; the data in the journal paper are the same as those raw data presented in the open-file report listed above. The study was entirely successful; I don't know whether we will need to do additional work in Canyonlands next year so I checked "completed", but if at some time in the future we would benefit from collecting additional data, I will contact the Park to ask about resuming permission to work there.

4) Study Title: Impacts of Climatic Change and Land Use on the Southwestern U.S.
Permit No.: CANY-2010-SCI-0004
Principal Investigator: Jayne Belnap
Purpose of Scientific Study: The population of the southwestern United States has grown rapidly over the past two decades and is projected to increase greatly over the next several decades. As the population has grown, climatic variations that would have affected relatively few people in the past will impact the lives of millions. Rapid and wide-spread climatic changes, such as those seen thousands and hundreds of years ago in the region and those projected for the future, may profoundly change the character of the region. Arid and semi-arid regions of the southwestern U.S. are among the most sensitive regions to changes in climate and land use, but the potential interactions between climatic change and land use are largely unknown (http://climweb.cr.usgs.gov/info/sw_new/swmap.html). U.S. Geological Survey and collaborating scientists are seeking to understand how climate and how land use has influenced surface geologic processes that modify landscapes and ecosystems. Such understanding is then used to model the landscapeâ s response to future changes in climate and land use over time scales of seasons, of a few years, and of a few decades, so that information and interpretations can be applied by federal, state, and local agencies, as well as by Native American governments, for their land-use planning and management of resources.
Project scientists work with ecologists, hydrologists, geographers, cartographers, and archeologists to address questions about:
(1) the causes and timing of changes in alluvial environments (rivers, streams, hillslopes), such as flooding, the cutting and filling of arroyos, and sediment discharge;
(2) the role of eolian dust for soil fertility, invasion of exotic species, hydrology, and surface stability in deserts;
(3) the interaction of physical and biologic processes critical for ecosystem functions;
(4) how climate in the southwest has varied over decades, centuries, and millennia;

(5) how future climatic variations will affect the Southwestern land surface (in terms of erosion, sand-dune activity, dust-storm frequency, flooding, landslides,);
(6) how past climatic changes and environments affected prehistoric cultures.
General Project Goals
-- Understand how past climatic change affected land surface: soil loss, fluvial erosion and alluviation, sand-dune mobilization, ecosystems, under time frames of past decades, centuries, and millennia.
-- Understand today's interplay among climate, land use and surface processes (geologic and ecologic).
-- Understand the impacts of future climate on land surface under the following time frames: seasons; El Nino/La Nina cycles; multiyear wet/drought periods; and decades, as atmospheric CO2 increases.
A major goal is to interact with federal, state, and local government agencies as well as non-governmental organizations to provide information useful for management decisions regarding land-surface vulnerability to wind erosion. Another goal is to provide to managers and other parties ongoing remote sensing and meteorological monitoring bearing on the vulnerability of the land to natural and human disturbances.
Specific goals for Canyonlands work
-- Understand geologic origins of soil nutrients and the interactions of soil compounds and plants.
-- Understand geomorphic controls on plant distribution
-- Understand the recent (past several decades, centuries, millennia) geologic/geomorphic evolution of the ecosystem to reveal patterns of surface stability and instability.
-- Recognize areas vulnerable to wind erosion and soil loss.
-- Understand conditions of cheatgrass (and other exotic plants) invasion to predict areas most vulnerable to expansion and to help devise mitigation strategies.
Findings/Accomplishments for 2010: This is a long-term project, with which we hope to understand climatic variability and its effects on dust projection and soil fertility.
Multiple years will be required to capture the full range of variability so that we may better understand the role of extreme events, as well as normal regimes.

5) Study Title: Atmospheric Dust Deposition to Canyonlands National Park
Permit No.: CANY-2010-SCI-0005
Principal Investigator: Jayne Belnap
Purpose of Scientific Study: The purpose of installing a total suspended particulate (TSP) sampler at Island in the Sky, Canyonlands National Park is to quantify the transport of windblown dust and to characterize the temporal variations in the chemical composition of this dust. Dust is a major atmospheric contaminant and a primary cause of reduced visibility in National Parks and other Class 1 airsheds. Despite the importance of dust to air quality and visibility, the sources, variability and composition of dust is not well understood. Accordingly, we are proposing the installation of a dust collector at Island in the Sky in CNP in order to develop a long-term dataset on dust deposition to the park. There are many factors that control the emission of dust from arid ecosystems including both land-use and climate. However, in order to better assess the quantity of material that is moved as well as its geochemical composition, we need the ability to regularly collect samples of suspended dust. The proposed sampler will provide a tool for the collection and chemical analysis of dust on a regular timescale and will greatly improve our estimates of dust fluxes to and from Canyonlands NP. The TSP sampler is a simple instrument that allows for the high volume filtration of suspended particulates. It consists of a 7.0 amp pump motor that is housed in an aluminum enclosure, resembling a large birdhouse. The pump pulls air over the lip of the aluminum enclosure through an 8â x10â filter paper. The physical barrier provided by the lip prevents large objects such as leaves or insects from being collected on the filter but does allow the collection of a large range of particle sizes. In comparison with

other common aerosol sampling equipment, such as those used by the IMPROVE network, the TSP is able to collect a more representative sample of suspended dust. Additionally, because the TSP rapidly samples high volumes of air, more concentrated samples can be collected. The flux of dust from Canyonlands ecosystems has important ecological implications. Dust is generated from the wind erosion of surface soils and this process is most extreme in arid and semi-arid ecosystems. Both the removal and subsequent deposition of dust can influence the ecosystem nutrient cycling and productivity. For example, the removal and/or redistribution of surface soils in arid ecosystems have been shown to alter the nutrient composition of surface soils and to influence the heterogeneity in vegetation composition. Additionally, dust exported from the arid southwest can be represent and significant input of materials to downwind ecosystems as far away as the Rocky Mountains.
Findings/Accomplishments for 2010: Dust collector is maintained, and samples are regularly collected by NPS personnel in the ISKY district of Canyonlands.

6) Study Title: Annual Forest Land Inventory
Permit No.: CANY-2010-SCI-0006
Principal Investigator: Renee O'Brien
Purpose of Scientific Study: The Interior West Forest Inventory and Analysis program is responsible for statewide inventories in eight states. The purpose of this ongoing inventory is to gather information on condition and trends of forest resources to assess plant diversity; fuels and potential fire hazards; condition of wildlife habitats; mortality and risk associated with fire, insects, or disease; and biomass, carbon storage, forest health and other general characteristics of forest ecosystems. Under the annualized inventory system, each field plot is visited one every 10 years, with approximately 10 percent of the total plots visited each year within a state. The FIA program produces a five-year report for each State.
Findings/Accomplishments for 2010: As part of the Annual Forest Land Inventory of Utah, field crews visited three plots within Canyonlands National Park during the 2010 field season. Two plots were forested and the field crew collected detailed vegetation information. One plot was found to be inaccessible by foot by the field crew.
Site-specific summaries of field data from the forest plots, in PDF form, will be sent to the designated NPS contact person. The results of this ongoing inventory are periodically updated and made available at www.fs.fed.us/rm/ogden/publications/.

7) Study Title: Recreation Impact Assessment: Canyonlands National Park
Permit No.: CANY-2010-SCI-0007
Principal Investigator: Pam Foti
Purpose of Scientific Study: Canyonlands National Park protects 337,598 acres of southeast Utah's high desert and provides some of the southwest's best examples of colorful canyons, buttes, fins, arches, and spires. There are four Districts within the park including, as follows: the Island in the Sky District, the Maze District, the Needles District, and the Rivers (Colorado and Green). This project focuses on motorized dispersed recreation in the Island in the Sky District, a section of motorized dispersed recreation in the Maze District, and river sections on both the Colorado and Green Rivers within the Park. The Island in the Sky District is readily accessible to visitors and offers a variety of pullouts with spectacular views along a paved road. This study focuses on the White Rim Road which is a 100 mile loop around the Island mesa top. There are 20 designated campsites along the loop arranged in 10 camping areas. Vault toilets are provided at all campsites along the White Rim Road, however, there are no water resources along the road; permits are required for overnight trips on this road. The Maze is the least accessible district of the park due to its remoteness and the primitive nature of the roads and trails. The primitive road condition is tied directly to Canyonlands' management goals for the area in terms of

maintaining the District as a "vast unoccupied space" with the opportunity for "unconfined recreation in primeval surroundings." (Ref: Canyonlands General Management Plan)
Canyonlands NP includes sections of both the Colorado and the Green Rivers. From Mineral bottom on the Green River to the Confluence is 54 miles of flat water. The Colorado River runs through Cataract Canyon and from the Confluence to Hite Marina is approximately 45 river miles. There are no designated campsites along the river sections in Canyonlands NP and campsites often change based on river level.
This project includes campsite monitoring along two river sections in a backcountry setting and dispersed recreation monitoring along roaded areas with motorized use in a primitive setting. The campsite monitoring along the river sections will focus primarily on "problem assessment" and collect data on recreational nodes along the river.
Dispersed monitoring with motorized use in primitive settings is a more challenging impact assessment process. Not only are the recreation impacts concentrated in campsites, but they may also be distributed along the travel route. Motorized recreation travel is a prime activity in today's world and requires specialized monitoring techniques, such as a dynamic stream of information which tracks impacts along the route, to obtain the best view of the diversity of recreation impacts. There is also no doubt that physical impacts related to motorized recreational use are one of the major concerns for federal agency land managers. Motorized recreational travel can have impacts on roads, in terms of creating pull-outs, increasing road width, and affecting the distribution of ruts and road depth. Use can also compromise open areas, such as meadows, riparian areas, and hills/grades. In some cases, recreational users develop illegal "play areas" without agency support or consideration. In other situations, motorized recreational use can lead to intrusions of livestock areas, tanks and ponds, streambeds, and cultural/historic sites.
Finally, dispersed motorized recreational use can lead to vegetative impacts, introduction of noxious weeds, soil erosion and disruption of fragile soil crusts.
Findings/Accomplishments for 2010: Data collection and data entry has been completed in all areas except Salt Creek. The Fall weather impacted the field researcher's ability to complete all of the backcountry areas. Salt Creek assessment is scheduled for May 18-20, 2011. Data reporting is anticipated for June, 2011.

8) Study Title: Monitoring the Colorado pikeminnow population in the mainstem Colorado River via periodic population estimates
Permit No.: CANY-2010-SCI-0008
Principal Investigator: Douglas Osmundson
Purpose of Scientific Study: To periodically provide population estimates of the Colorado River population of the endangered Colorado pikeminnow. Such estimates were made during 1991-1994 and 1998-2000, and 2003-2005. Our office will initiate a new three-year study beginning in 2008. The study area extends from Palisade, Colorado to the confluence with the Green River in Utah (185 miles). The lower 40 miles of the study area is within Canyonlands National Park.
Findings/Accomplishments for 2010: In 2010, four complete passes were made through the upper and lower reaches as planned, but a fifth pass planned for the upper reach (due to low numbers of pikeminnow captures) was not able to be completed prior to the initiation of the spawning season.
Consequently, capture data collected during the first two weeks of the smallmouth bass removal project (Project 126) were used to assemble a fifth pass. Sampling for the first four passes was conducted from April 7 through June 18. A fifth upper-reach pass was conducted immediately after the estimated Colorado pikeminnow spawning season from August 2 through August 16. Numbers of fish captured were similar to 2008 and 2009. In the upper reach, there was a mean of 17 Colorado pikeminnow captured per pass (87 total); in the lower reach, a mean of 27 pikeminnow were captured per pass (106 total). Total within-year recaptures in the upper reach were higher in 2010 (7) than in 2008 (five), but lower

than in 2009 (11). In the lower reach, total within-year recaptures were higher in 2010 (12) than in 2009 (seven) and 2008 (10). In both 2008 and 2009, the duration of spring runoff was especially long and made for good electrofishing and backwater netting conditions. The period of runoff that allows backwater trammel-netting was shorter in 2010. In 2008, there were 41 boat-days expended on trammel-netting compared to 37 in 2003, three in 2004, and 41 in 2005. In 2009, there were 37 trammel-netting boat days, and in 2010, 24 such boat days. Considering this, lack of backwaters would not explain the lower numbers of captures in recent years. Subtracting the number of captures attributable to the bass removal effort (Project No. 126), the total number of pikeminnow captured in 2005 was 319 (four passes in upper reach; five passes in lower reach). In contrast, the total captured in 2008 was 185 (five passes in upper reach; four passes in lower reach), or 42% less than in 2005. Similarly, in 2009 there was a total of 188 pikeminnow captured (five passes in upper reach; four passes in lower reach), or 41% lower than in 2005. Similarly, in 2010 there was a total of 176 pikeminnow captured when the fifth upper-reach pass is subtracted (four passes in each reach), or 45% lower than in 2005. During 2003-2005, there was a large group of young Colorado pikeminnow detected that was attributed to a strong year class produced in 1998 (see Osmundson and White 2009). No such strong year class was detected in 2008, 2009 or 2010. In addition, probability of capture was found to vary fairly substantially among years, in part explaining the higher numbers of fish captured in 2005 than in 2003 or 2004. Hence, the 41-45% lower number of pikeminnow captured in this recent 3-year effort than in 2005 cannot be ascribed at this time to the population declining by such amounts, but instead may be a function of lower probabilities of capture. Until program MARK is used to analyze the data, caution must be exercised when interpreting these numbers of total captures. To date, data from 2008, 2009 and 2010 have been entered into Excel and checked for errors. The capture history matrix for these three years has also been developed. Unfortunately, these new captures could not be appended to the 1991-2005 capture history matrix because PIT tags and associated readers have changed and the older tags cannot be reliably detected by the new readers. Undetected pit-tagged fish would cause survival rates to be underestimated (erroneously low). Hence, a new matrix had to be started from scratch that includes only captures of fish containing the new tags. No preliminary estimates of population abundance or other vital rates have been produced yet from the new matrix. A final report will be prepared in 2011. Sampling in Canyonlands National Park (RMI 0-34) yielded a total of 45 Colorado pikeminnow in 2010.

9) Study Title: NCPN Integrated Upland Monitoring in Canyonlands National Park
Permit No.: CANY-2010-SCI-0009
Principal Investigator: Dana Witwicki
Purpose of Scientific Study: The Northern Colorado Plateau Inventory and Monitoring Network (NCPN) of the National Park Service has identified upland ecosystem characteristics, processes, vegetation, and other biota as vital signs to be monitored. Upland monitoring is intended to strike a balance between increasing fundamental understanding of dryland systems and providing managers early warning of undesirable change. It will document the variability in these systems while providing information needed for resource management decisions. Addressing these two goals will be accomplished partly through sampling design and data analysis. Some sites may be selected as representative of large portions of the landscape, others because of their management history. Evaluation of upland monitoring data in relation to other vital signs will facilitate identification of drivers and distinguishing "natural" from anthropogenic change. Additionally, plot data from this effort will be used in the classification and interpretation of remotely sensed data.
NCPN upland monitoring objectives for selected ecological sites:
1. Determine annual status and trends in ground cover (live and standing dead vegetation, litter, rock, biological soil crust, and bare ground); spatial pattern of vegetation by life form;

soil aggregate stability and compaction as indicators of soil/site stability; hydrologic function, and nutrient cycling.
2. Determine annual status and trends in cover of biological soil crusts by species or morphological group.
3. Determine annual status and trends in cover of exotic plants in upland areas.
To better evaluate monitoring methods and objectives, the NCPN proposes to implement a three year pilot study at CANY. This will be the final year of the pilot study.
Findings/Accomplishments for 2010: 48 plots were sampled in grassland, shallow blackbrush and blackbrush/PJ ecosites in the Island in the Sky and Needles districts. Reconnaissance of potential future monitoring plots was also completed. All plots were checked for cultural resources during reconnaissance and again during establishment or revisit. An annual report of 2009 data was completed and sent to resource management staff.

10) Study Title: Colorado River Tamarisk Biological Control Monitoring Project: Loma, Colorado to Lake Powell
Permit No.: CANY-2010-SCI-0010
Principal Investigator: Lindsay Clark Tate
Purpose of Scientific Study: The purpose of this study is to support a body of knowledge to determine the value of the tamarisk leaf beetle, Diorhabda carinulata, as a tamarisk biocontrol agent, on the Colorado River from Loma, CO to Lake Powell, UT. The four goals of this study are to obtain data concerning the dispersal and establishment of D. carinulata, measure the efficacy of the beetle in controlling tamarisk, monitor the safety of biological control, and to ascertain the impact of biocontrol on riparian ecology. The overall impact of D. carinulata on western ecology is not well understood. Preliminary studies show that local birds and generalist arthropods gain a significant food source with the introduction of the beetle (Dudley and DeLoach 2004, DeLoach et al. 2004, Herrera et al. 2001). This is beneficial for tamarisk ecosystems as they support less arthropod abundance than native vegetation (Stevens 1985, Shafroth et al. 2004). Defoliation by D. carinulata also immediately reduces the amount of water tamarisk is able to transpire (Pattison et al. 2006), increases branch mortality, decreases flower and seed production, and in some situations causes plant mortality (Kazmer et al. 2006). Among factors most critical to tamarisk biocontrol success is the ability to predict and control beetle dispersal and establishment. Tamarisk mortality in cage tests was achieved following three sequential seasons of defoliation. Initial field studies indicate that more seasons of defoliation may be required to achieve tamarisk die off. In some instances beetles avoided plants that had been defoliated the year before, affording the tamarisk a recovery period and decreasing chances for mortality (Dudley and DeLoach 2004). Thus, ensuring beetle population longevity in any one area is essential to successful tamarisk control. Data collection will provide information to support the three major long-term research objectives shown below with their correlating short-term objectives:
(1) To obtain data that will aid in the future prediction and control of D. carinulata dispersal and establishment. Gathering such data is invaluable to predict patterns and rates of eventual tamarisk mortality rates. Thus, the first immediate objective is to: (a) track largescale dispersal patterns of D. carinulata.
(2) To measure the efficacy of D. carinulata, in the control of tamarisk. Efficacy data will provide critical information to biocontrol viability. Therefore, the second immediate objective is to: (b) measure tree stress by recording changes in tree morphology (i.e. defoliation).
(3) To ascertain the safety of D. carinulata as a biological control agent. The possibility of biocontrol agents switching hosts is a concern. Although there are no recorded host-plant switches in weed biocontrol it is prudent to note any feeding, damage, beetle development, or population suppression of non target plant populations. For this reason one objective will be to: (c) routinely survey non target plants for the presence of D. carinulata. Beetles have

been found on other plants but in no instance have they persisted or impacted plants other than tamarisk.
(4) To study the impact of D. carinulata on riparian ecology. To date data shows an increase in other non-native plants (kochia, Russian knapweed and perennial pepperweed) in tamarisk defoliation areas. This information was gathered at sites (Lovelock, NV and Pueblo, CO) with little opportunity for other vegetation to establish. Thus, another objective is to: (d) collect a larger database of vegetative response to tamarisk defoliation.
These objectives represent research needs identified by several consortia of scientists and practitioners such as the Saltcedar Biological Control Consortium of Texas, New Mexico, and Mexico and participants in the Tamarisk Research Conference held in Ft. Collins, CO in October of 2006. The results of these western Colorado research objectives will inform ongoing research analyzing D. carinulata.
Findings/Accomplishments for 2010: Surveys occurred: 8/14/10-8/19/10 Colorado River, 8/14/10-8/16/10 Green River *All River Mile (RM) references correspond with Belknapâ s Canyonlands River Guide. On the Colorado River in August 2010, high densities (26 or more beetles/sample) of beetles were found above and around RM 49 (Potash boat ramp). Individuals and light densities (5-25 beetles/sample) were observed downstream to RM 29 (near Little Bridge Canyon), where densities increased to high levels. Moving downstream, moderate densities were found until RM 18 (Sheep Bottom). Through the Green River confluence to Hite densities were mostly light or absent with the exceptions of the following reaches: RM 212 (Rapid 2) to RM 206, RM 190 (Bowdie Canyon) to RM 184 (Rockfall Canyon), and RM 175 (Mille Crag Bend) to RM 170 (Dirty Devil River).
Tamarisk leaf beetle defoliation on the Colorado River in August 2010 was interspersed throughout the entire reach from Potash to Hite. Moderate to heavy defoliation (21-100%) occurred from Potash downstream to RM 7 and from RM 6 to RM 100 (Imperial Canyon). Areas of heavy defoliation (50-100%) were observed from RM 199 to RM 192 (Clearwater Canyon). Defoliation was light to moderate (1-49%) from Clearwater Canyon to Hite. Signs of re-foliation began at RM 16 (Monument Creek) and continued downstream to Hite.
On the Green River in August 2010, tamarisk leaf beetle presence was much more sparse than the Colorado River side. From Mineral Bottom (RM 52) downstream to Queen Anne Bottom (RM 33), beetle numbers were limited, with mostly individuals, except around RM 33 (Queen Anne Bottom), RM 21 (Turkâ s Head), and RM 4 (Water Canyon) where light beetle densities were present. Defoliation on the Green River in August 2010 was light to moderate (1-49%), with a marked increase around RM 31 (Anderson Bottom). All of the tamarisk on this section of the Green River appeared to be experiencing some level of re-foliation. Along both the Colorado and Green Rivers coyote willow (Salix exigua) was found to be the predominant secondary species alongside tamarisk, found present at 70% of sites surveyed along the Green River. Similarly, 82% of the points surveyed along the Colorado from Potash to Spanish Bottom had willows present. Comparatively only 9% of points had willows present below Spanish Bottom, with the predominant secondary species being Russian thistle (Salsola tragus) at 48% of the points surveyed. During the surveys tamarisk leaf beetles were not recorded feeding upon any plant species, but tamarisk.

11) Study Title: Climate change in dryland regions: response of ecosystem components, including biological soil crusts, vascular plants and soil nutrients, to decreased soil moisture. (Rainout Shelters)
Permit No.: CANY-2010-SCI-0011
Principal Investigator: Jayne Belnap
Purpose of Scientific Study: Long-term climate models predict that the southwestern area of North America will experience a significant decrease in annual precipitation over the coming decades. This research study is part of a larger project that has sites located throughout Southeastern Utah investigating the effects of decreased precipitation on biological soil crusts and the surrounding vegetation of multiple different plant and soil

communities. The big project plans to look into the sensitivity and thresholds in biocrusts, native and invasive plants, dust production, and snowmelt in the western United States. The Park's land provides us with areas which have been fenced off from cattle, which would be a fantastic addition to the other sites available to us for this research. At each of the four research sites in Canyonlands (two in the Needles district and two in ISKY) there are two experimental plots, a control plot and a plot that has a rainout shelter. This shelter is designed to prevent approximately 25% of all precipitation events from reaching the soil surface by a series of gutters that divert the precipitation off of the plot. Each of the sites also has an automated datalogger that records air temperature and relative humidity, precipitation, and soil temperature within each plot. Throughout the study we will monitor the biological soil crust and plants within each plot to determine the effects on species composition and survivability with respect to the different precipitation regimes.
This project addresses USGS Science Strategy (1. Ecosystems, 2. Climate Variability), the US Climate Change Program Strategic plan (8.1, Feedbacks; 8.2., Potential ecosystem consequences, 8.3., Options) and Goals 1, 2, 3 and 4 of the BRD Global Change meeting notes.
Findings/Accomplishments for 2010: During this first year of the study, the experimental plots were established at the four locations in the park. We also collected the first set of measurements looking at the soil and plant characteristics within the control and shelter plots. We are currently processing and analyzing this data.

12) Study Title: Hydrology and geomorphology in Arid River Systems: A Case Study in Canyonland Country (Evaluation of vehicle impacts in Salt Creek)
Permit No.: CANY-2010-SCI-0012
Principal Investigator: Anne Brasher
Purpose of Scientific Study: To study the hydrology and geomorphology of the Salt Creek watershed in the Needles District of Canyonlands National Park. This study seeks to understand linkages among hydrologic, geomorphologic, and riparian characteristics to help predict stream health and stream channel trends in arid river ecosystems. The study will look at natural versus anthropogenic impacts to the stream.
Findings/Accomplishments for 2010: Channel cross sections were re-surveyed in 2010 and will be useful for comparing temporal changes in channel geomorphology. A report will be provided to the park upon completion.

13) Study Title: Repeat Photography of Cataract Canyon and Vicinity, Southern Utah
Permit No.: CANY-2010-SCI-0013
Principal Investigator: Robert Webb
Purpose of Scientific Study: From 1991 through about 1995, our research group matched approximately 270 photographs of the Colorado River in Canyonlands National Park, particularly in Cataract Canyon. Of these, 60 were originally taken during the Brown-Stanton expedition of 1889 and 25 by the 2nd Powell Expedition in 1871. We propose to rematch these photographs and to assess mortality and recruitment information for common species of desert and riparian vegetation along the river corridors.
Findings/Accomplishments for 2010: We matched 35 photographs taken by Franklin A. Nims in May-June 1889 and first matched between 1991-1996. These photographs generally document changes in desert vegetation but also changes in riparian vegetation along the Colorado River.

15) Study Title: Colonial waterbird nesting survey
Permit No.: CANY-2010-SCI-0015
Principal Investigator: Valerie Frokjer

Purpose of Scientific Study: We are currently conducting a colonial waterbird nesting survey for the USFWS through the Weber State University Avian Ecology Laboratory. We are locating nesting sites for all of the following species of birds using scopes, binoculars, boat or walking, whichever means are necessary for the situation to locate these birds. Eared, Western, Clark Grebe; American white pelican; Cormorant; Great blue heron; Great, Snowy, Cattle Egret; Black crowned night heron; White-faced ibis; Franklin's, Ring-billed, California Gull; Caspian, Black, Forster's Tern The prioritized objectives of this survey are: 1) inventory and atlas of current waterbird colonies; 2) inventory of historical sites; and 3) locating new colonies.
Findings/Accomplishments for 2010: The stretch of the Colorado River between Potash and the Green River confluence was surveyed by Doug Osmundson and Greg Fraser from the USFWS. They volunteered to survey this section and share the information with our study as they had the proper equipment and were planning several trips to the area throughout the summer. Just past Schaeffer Canyon they found 1 nest and 1 Great Blue Heron GBHE adult along the cliffside on 6/4/10. A cliffside rookery was found on 6/1/10 along the Colorado River. This rookery contained 1 nest, but could not be confirmed as active due to its location. A possible rookery was spotted on a cliff along the Colorado River at on 6/1/10. Eight patches of white fecal wash typical of the cliff nests were seen. However, no adults were observed. Another site had 4 patches of white fecal wash along the Colorado River, but no adults were seen on 6/2/10; 3 nests and 1 adult were seen on the cliff top along the Colorado River. They counted 3 nests at the Potash rookery on 6/4/2010. One nest and 1 Great Blue Heron adult were seen on the cliff top on 6/4/10.

16) Study Title: Slack water deposits along the Green River
Permit No.: CANY-2010-SCI-0016
Principal Investigator: John Weisheit
Purpose of Scientific Study: To locate and investigate slack water deposits, which are perched river sediment deposits from extreme flooding events along the margins of the high water zone. Long-term (older than the instrument record) flood volumes and frequency can be determined by these deposits. The data are useful to agencies, such as the Bureau of Reclamation.
Findings/Accomplishments for 2010: Assessment of Future Paleoflood Analysis Sites, Lower Green River. In early July, 2010, we did a reconnaissance survey of the lower Green River, near its junction with the Colorado. Our preliminary analysis of data from this survey indicates that the lower Green River canyons contain an excellent record of extreme paleofloods, probably occurring within the last few thousand years. Using our field survey of paleostages reached at 14 sites along the Stillwater Canyon reach of the lower Green River, we estimated cross-sectional areas for the hydraulic geometries at the respective flood stages. Multiplying these cross-sectional areas by mean flow velocities determined for analogous hydraulic geometries (similar slope, similar cross- sectional areas and dimensions) by HEC-RAS analyses of the Moab Study Site on the mainstem Colorado River (Greenbaum et al., 2010), we estimate paleodischarges achieved at the 14 Stillwater Canyon sites along the Green. As shown in the table below, the peak flows achieved on the Green River seem to have reached at least 6000 cubic meters per second (cms) and perhaps as high as 8000 cms. Although we did not have the resources to do the geochronology, the flood deposits are clearly late Holocene and probably comparable in age to the deposits at the Moab Study Site (i.e., the last few thousand years).
The importance of these values can be appreciated by the fact that the largest historically documented flood of the Green River is that of 1884, with a peak flow estimated at approximately 2830 cms (6370 cms on the Colorado below its confluence with the Green, minus the 3540 cms contributed by the main-stem Colorado above the confluence).

These results show that a future in-depth survey, similar to what we did for the Moab Study Site (Greenbaum et al., 2010), would significantly transform our understanding of the magnitude and frequency of extreme flood phenomena on the entire upper Colorado system (including the Green River), showing that the modern stream gage records are totally inadequate for understanding extreme flood phenomena in this system. This conclusion points to the need for a much more extensive paleoflood study of the upper Colorado system than was possible in this limited reconnaissance study.

Reference Cited

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2006. In: Weisheit, J.S., and Fields, S.M. (Eds.), The Moab Mill Project: A Technical Report Towards Reclaiming Uranium Mill
Tailings along the Colorado River in Grand County, Utah. Living Rivers, Moab, Utah, pp. 13-28.

17) Study Title: The Role of Biological Soil Crusts in soil nutrient cycles as Influenced by Soil Surface Disturbance, Climate Change and Annual Grass Invasion
Permit No.: CANY-2010-SCI-0017
Principal Investigator: Jayne Belnap
Purpose of Scientific Study: This project will establish how alterations in species composition by surface disturbance, invasive grasses, and/or climate change may affect N and C inputs and fluxes, in different soils under different climatic regimes.
Findings/Accomplishments for 2010: With this ongoing project, we are continuing to maintain our experimental plots and collect data. As we are looking at long-term effects of soil surface disturbance, we will continue to annually monitor change, and analyze data in the future.

18) Study Title: Chronostratigraphy of alluvium in Horseshoe Canyon and indirect dating of Barrier Canyon rock art: Phase II
Permit No.: CANY-2010-SCI-0018
Principal Investigator: Joel Pederson
Purpose of Scientific Study: The final phase of this research has the goal of constraining the age of Barrier Canyon-style rock art by focused sampling for optically stimulated luminescence analysis at the Great Gallery panel in Horseshoe Canyon. Through dating of sediment laterally adjacent to the panel, a more precise maximum age constraint can be obtained. Also, by dating of rockfall boulders below the rock art panel, some of which include pigmented surfaces, both a minimum age for the art and possibly a direct age of the art may be obtained.
Findings/Accomplishments for 2010: Results of sampling sediment adjacent to the Great Gallery were completed in spring of 2010, in the form of USU student Melissa Jackson's Senior Honor's thesis. This was provided to CNP as a reporting product, and the primary result is that the BCS rock art must be younger than ~6000 years old.
A sampling trip by USU personnel was conducted in July of 2010, in collaboration with several CNP personnel. This was conducted in the evening, with the goal of lifting and sampling the surfaces beneath talus boulders. Initial analyses on these samples have been conducted, with the exciting result that the rockfall event that cross-cuts a BCS panel figure dates to ~900 years ago based upon both OSL and AMS radiocarbon dating. Thus, the BCS art must be older than that. On the other hand, our analyses indicate that the rock art pigment we sampled did not itself completely shield the rock surface from sunlight, and thus OSL was not able to directly date the rock art in the samples we collected.
Final minor samples of unpigmented Navajo sandstone bedrock, at locations in CNP but far from any rock art panels, were obtained by PI-Pederson in the fall and early winter of 2010. Final analyses are currently being conducted on these samples to document the systematics

of the Navajo bedrock's luminescence properties. This includes exploring the degree to which OSL might be able to directly date such rock art, depending upon the thickness and darkness of the pigment.
Two or three manuscripts for scientific peer-review journals are either in preparation or planned. CNP will receive copies of these as soon as possible.

19) Study Title: Evaluating Mexican Spotted Owl Habitat Quality & Occupancy in Utah
Permit No.: CANY-2010-SCI-0019
Principal Investigator: Frank Howe
Purpose of Scientific Study: We propose to combine predictive habitat modeling with occupancy modeling to evaluate how habitat features influence Mexican Spotted Owl demographic parameters such as productivity and probability of site use. We will use a combination of protocol (hooting) surveys and remote recording devices to determine occupancy. We will measure geographic, geologic, topographic, and vegetative characteristics at each survey site and collect weather covariates using remote data loggers. Our study will be focused in the Dugout Ranch, Canyonlands National Park area in 2010 and expand to include most of southern Utah in the two following years.
Findings/Accomplishments for 2010: A total of fourteen hooting surveys were conducted within the park boundaries between July 20th 2010 and September 5th 2010. Canyons surveyed included: Lavender, Big Springs, Elephant, Separation, Salt Creek (Upper Jump), Chesler, Lost, Davis, and Squaw. A total of four Mexican spotted owls were detected (3 males and 1 female) at three different sites. The female owl was detected with a male on two separate occasions and they were presumed to be a nesting pair. The remaining two males were presumed solitary. Geologic, topographic, and vegetative characteristics were collected at ten random sites in Elephant Canyon. These data have not yet been analyzed. Travel conditions in the park were extremely challenging during the field season with above average rainfall leading to the closure of several park roads and trails. Several areas outside of the park boundary were also surveyed for owls on Bureau of Land Management lands. Canyons and areas surveyed included Lavender Canyon, Harts Draw, Dugout Ranch, and Owl Canyon. There were no Mexican spotted owls detected during these surveys.
20) Study Title: Dissolved-solids loads to the Colorado River in the reach between the Dewey Bridge and Lake Powell
Permit No.: CANY-2010-SCI-0020
Principal Investigator: Terry Kenney
Purpose of Scientific Study: The Colorado River between the Dewey Bridge and Lake Powell traverses a geographic area where underlying bedrock formations include saline sedimentary formations and evaporite deposits such as the Paradox Formation. The dissolved solids contribution to the Colorado River from this portion of the Colorado River Basin is poorly understood. We are proposing that a set of salt-load measurements be made in the Colorado River and its tributaries that would quantify and partition salt loading in this reach. It's been shown that active salt dissolution from the Paradox Formation underlying the Paradox Valley to the east of the proposed study reach contributed about 115,000 tons of salt per year to the Dolores River prior to the implementation of the Paradox Valley Salinity Control Unit (Chafin, 2003). However, it is not known to what extent similar or other processes are occurring in this formation near Castle or Moab Valleys, or whether these processes are resulting in substantial salt loading to the Colorado River. Additionally, the Cane Creek potash mine (a solution extraction and evaporation mining operation) is located adjacent to the Colorado River a short distance downstream of the Moab Valley and the contribution of dissolved solids to the Colorado River â if any â from this operation are unknown.
Findings/Accomplishments for 2010: First set of water quality and water quantity data have been acquired. Water quality samples have been submitted to the U.S. Geologlical

Survey National Water Quality Lab for analysis. Data analysis is ongoing. Plans for re-sampling sites in the fall of 2011 are being developed.

21) Study Title: Southern Utah Visitor Profile Study 2010
Permit No.: CANY-2010-SCI-0021
Principal Investigator: Emmett Steed
Purpose of Scientific Study: The purpose of this study is to understand Southern Utah's tourists, who stay overnight and travel more than 50 miles from their homes. The research seeks to answer the following questions:
1. What are the demographic characteristics of Southern Utah visitors?
2. What relationships exist among Southern Utah visitors in regard to place of origin, Southern Utah destinations visited, transportation utilized, activities selected while in Southern Utah, and trip expenditures?
3. Are there seasonal differences in origin, destinations, activities, and expenditures?
4. What are the information sources utilized by Southern Utah visitors?
Findings/Accomplishments for 2010: Upon completion of 2/4 seasons of data collection we have initial demographic information and an initial count of the most influential information sources utilized by Southern Utah visitors. Below are descriptive statistics from initial data analysis (n-456).
Specific to national parks:
79% of visitor surveyed are visiting national parks;
71% are influenced by the internet;
62% are influenced by past knowledge in their travel plans; 53% are influenced by friends/family.
Demographics of survey visitors:
Gender: 50% male;
Ages: 27% 45-54; 24% 55-64; 18% 35-44;
Originating area codes:
27% mountain zone;
26% foreign zones;
16% pacific zone;
Marital status: 74% married
Education level: 38% graduated college; 38% post graduate degree
Profession: 25% professional; 16% managerial/executive; 18% retired; 13% education
Travel club affiliation: 47% belong to AAA; 26% belong to AARP
Household income: 41% >$100,000; 25% $60,000-$99,999; <$59,999 16%